

# **New Perspectives for Brazilian-German Research on Circular Economy**

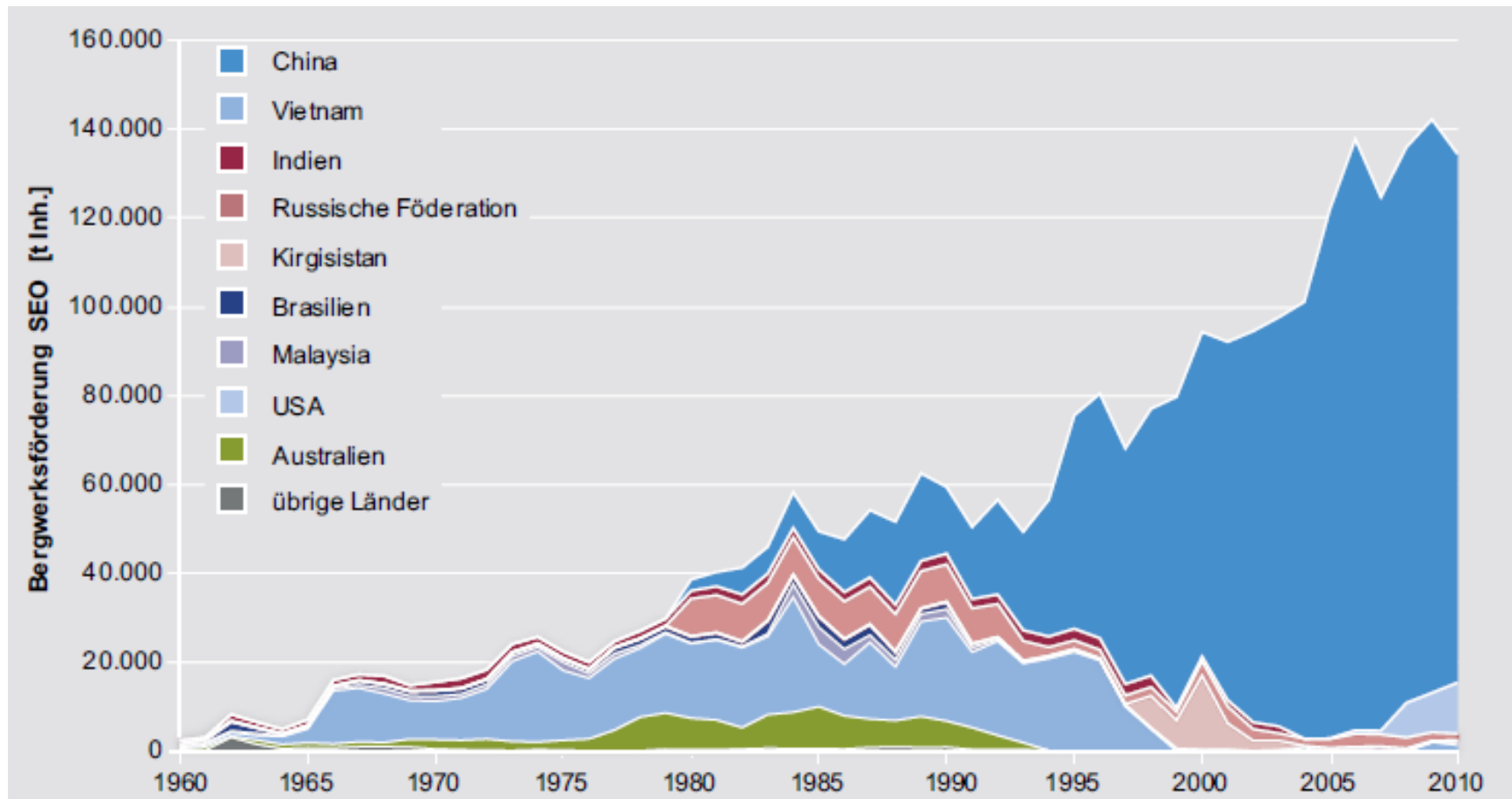
**Quinto aniversário do Escritório da Aliança Universitária do Ruhr no  
Rio de Janeiro**

# New Perspectives for Brazilian-German Research on Circular Economy

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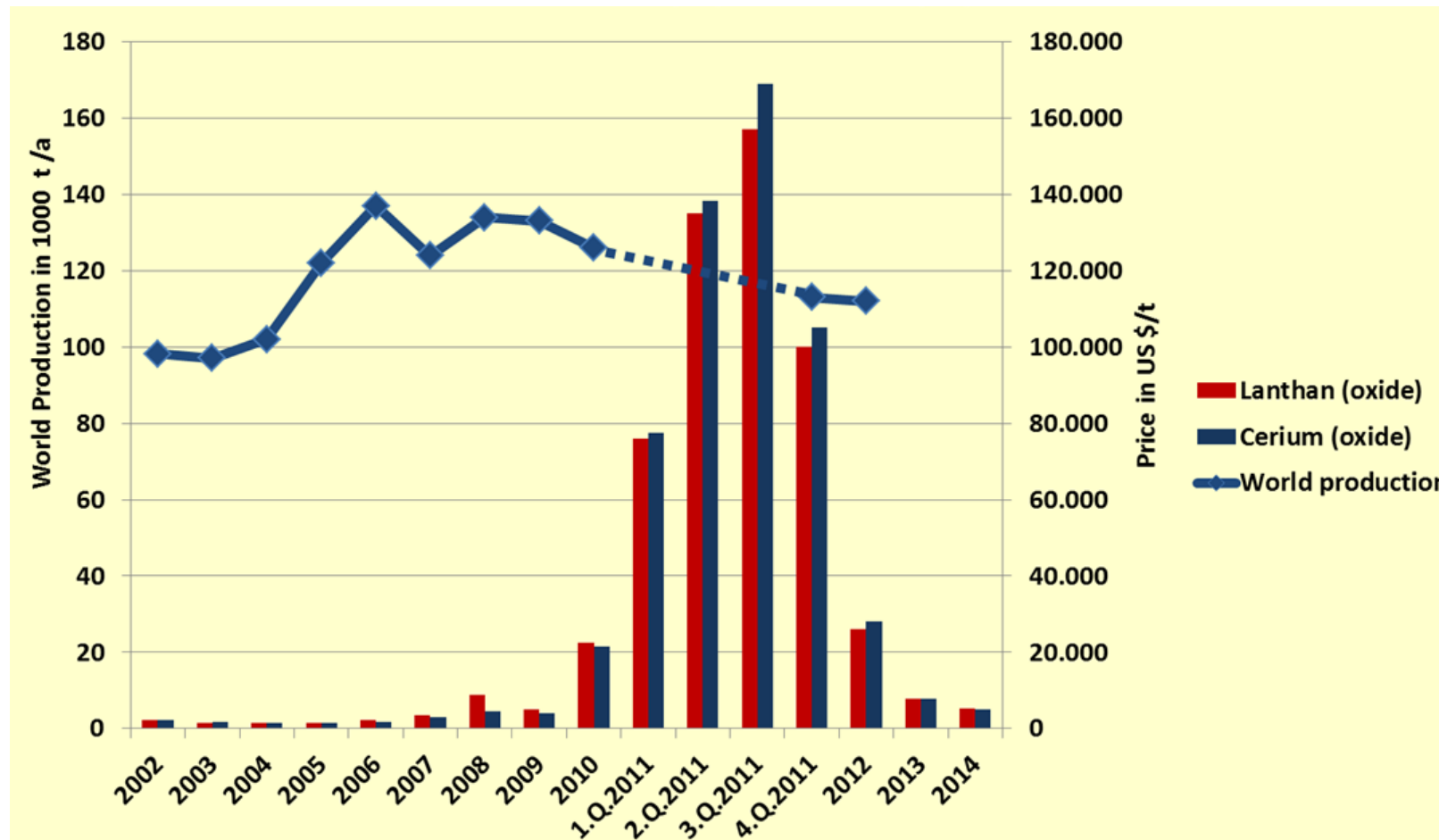
1. Global structural changes in raw material markets
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## Development of mining production of rare earth elements



Bundesanstalt für Geowissenschaften und Rohstoffe (BGR): *Seltene Erden, Rohstoffwirtschaftliche Steckbriefe*;  
Hannover 2014, [www.bgr.bund.de](http://www.bgr.bund.de)

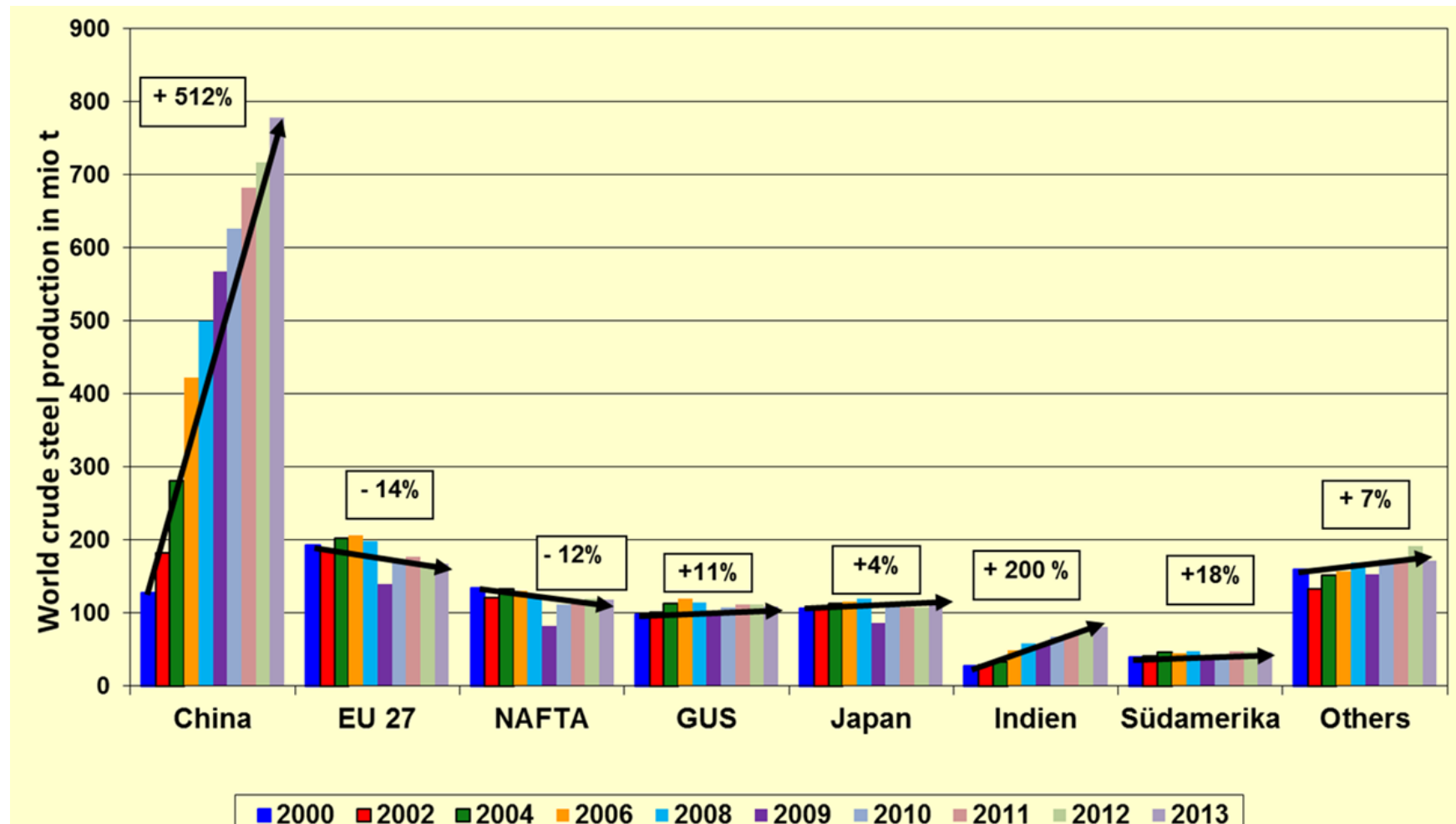
# Global production of rare earth elements and price developments of Lanthanum (LA) and Cerium (CE)



Data from United States Geological Survey, [www.usgs.gov](http://www.usgs.gov); British Geological Survey, [www.bgs.ac.uk](http://www.bgs.ac.uk),  
[www.seltenerdmetalle24](http://www.seltenerdmetalle24), [www.bgr.bund.de](http://www.bgr.bund.de)

Deike, R.: *Resource efficiency against a background of changing international markets for industrial metals*,  
 Kendrion Symposium 2015, Rottweil, 19.03.2015

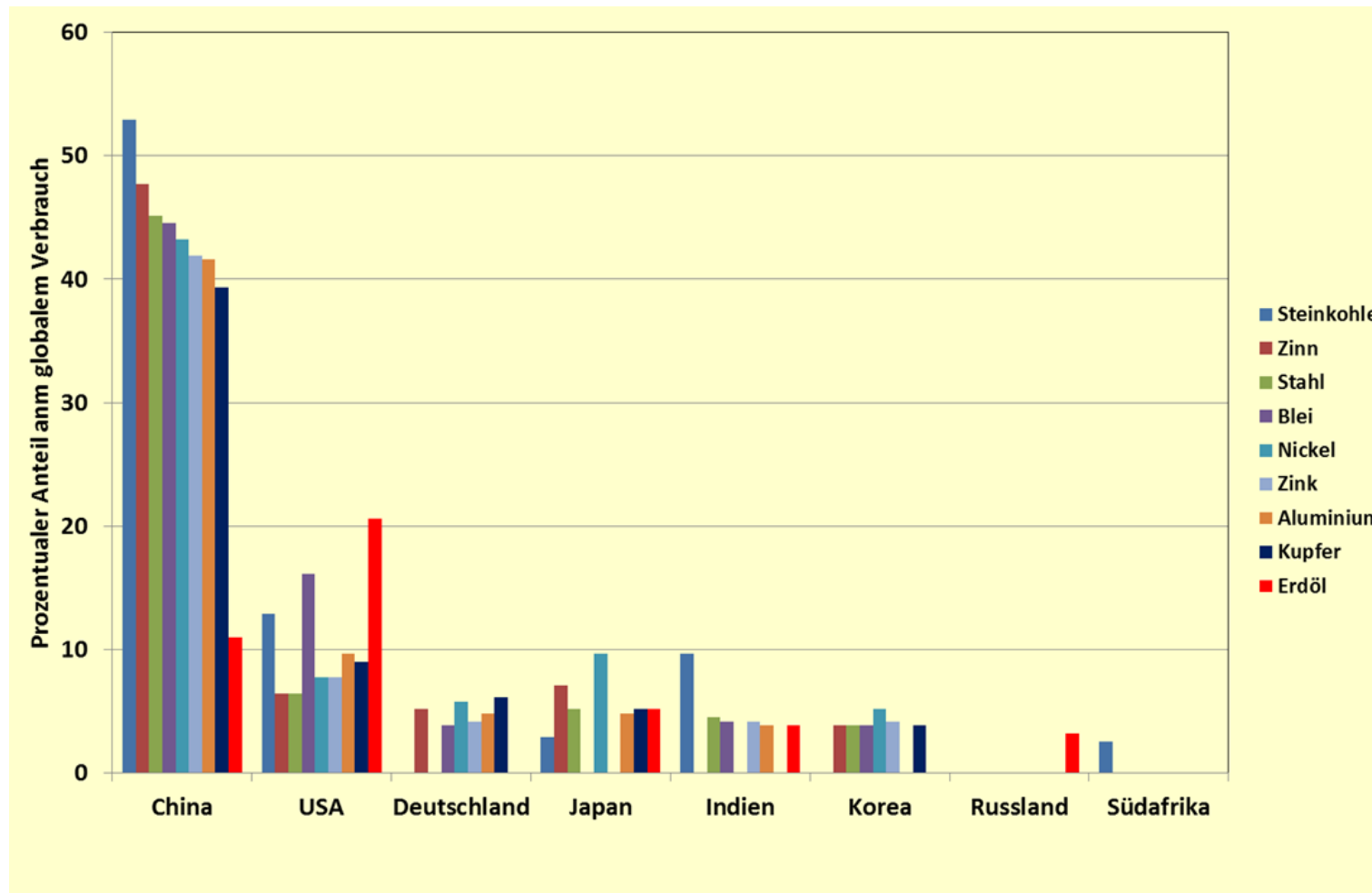
# Development of global crude steel production



Data from World Steel Association, [www.worldsteel.org](http://www.worldsteel.org)

Deike, R.: *Die Bedeutung der Stahlindustrie unter dem Aspekt einer nachhaltigen Rohstoffwirtschaft*,  
 175 JAHRE EISEN- UND STAHLMETALLURGIE AN DER MONTANUNIVERSITÄT LEOBEN, Leoben, 11.04.2015

## The global structural change can be seen from percentages of global raw material consumption of different nations

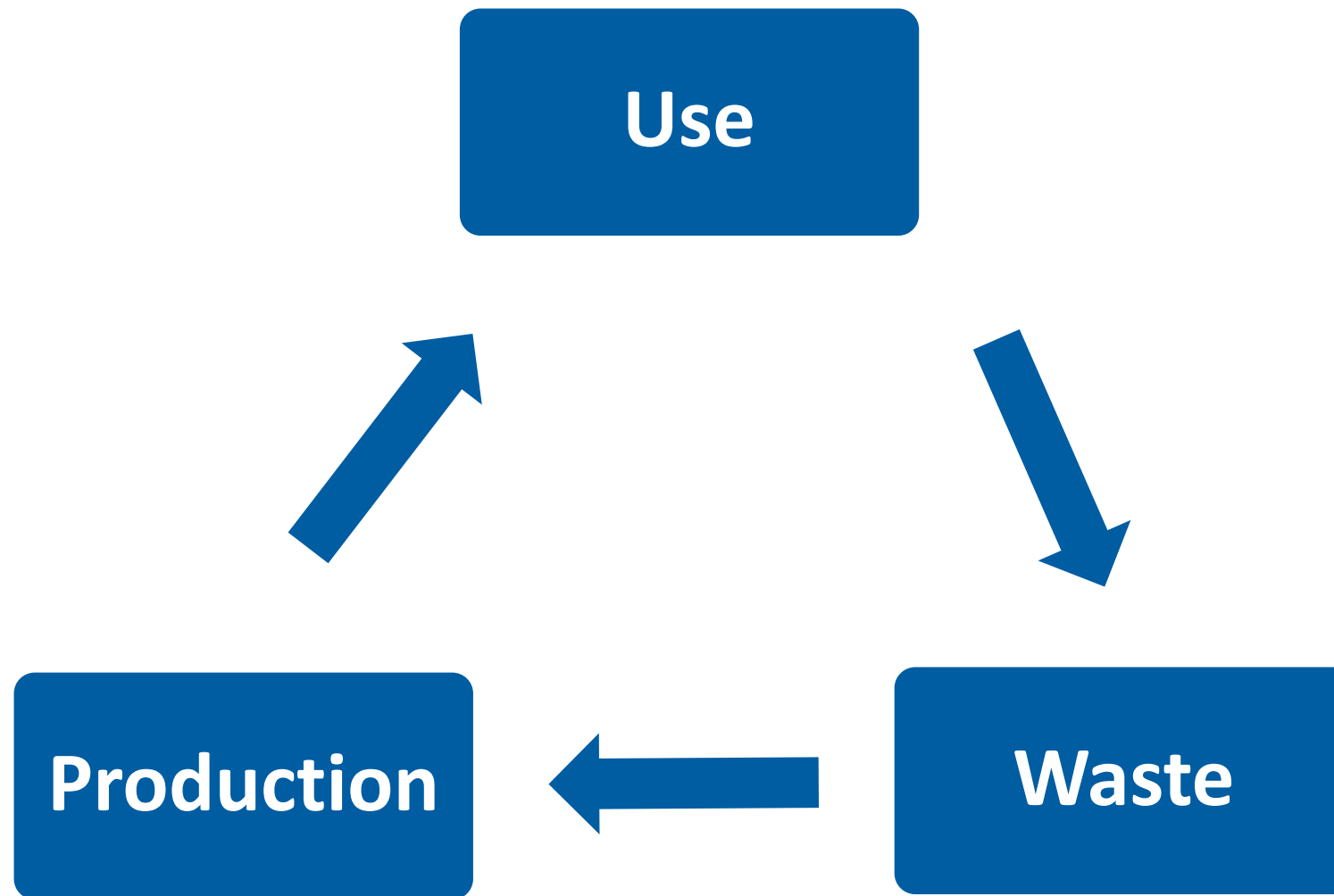


Data from DERA: Deutschland Rohstoffsituation 2011, [www.bgr.bund.de](http://www.bgr.bund.de)

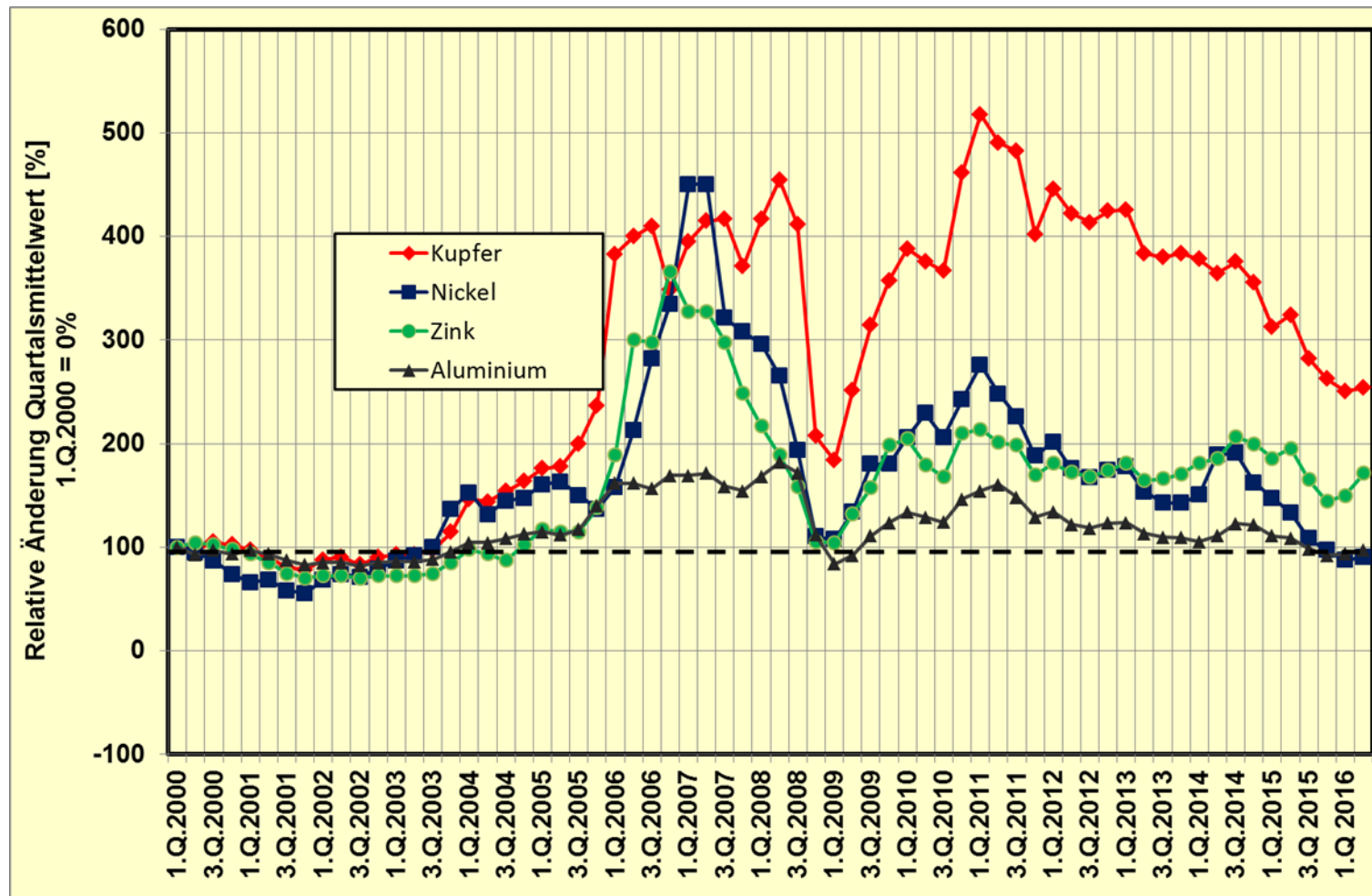
Deike, R.: Das wirtschaftliche Recycling von Metallen und Metalloxiden unter Berücksichtigung der wesentlichen Einflussgrößen, Urban Mining Congress 2014, Essen, 11-12.06.2014

<https://www.uni-due.de/mus/veroeffentlichungen.php>

## Fundamentals of Circular Economy



# Changes of different quarterly average metal prices based on year 2000



Data from London metal exchange , [www.lme.com](http://www.lme.com)



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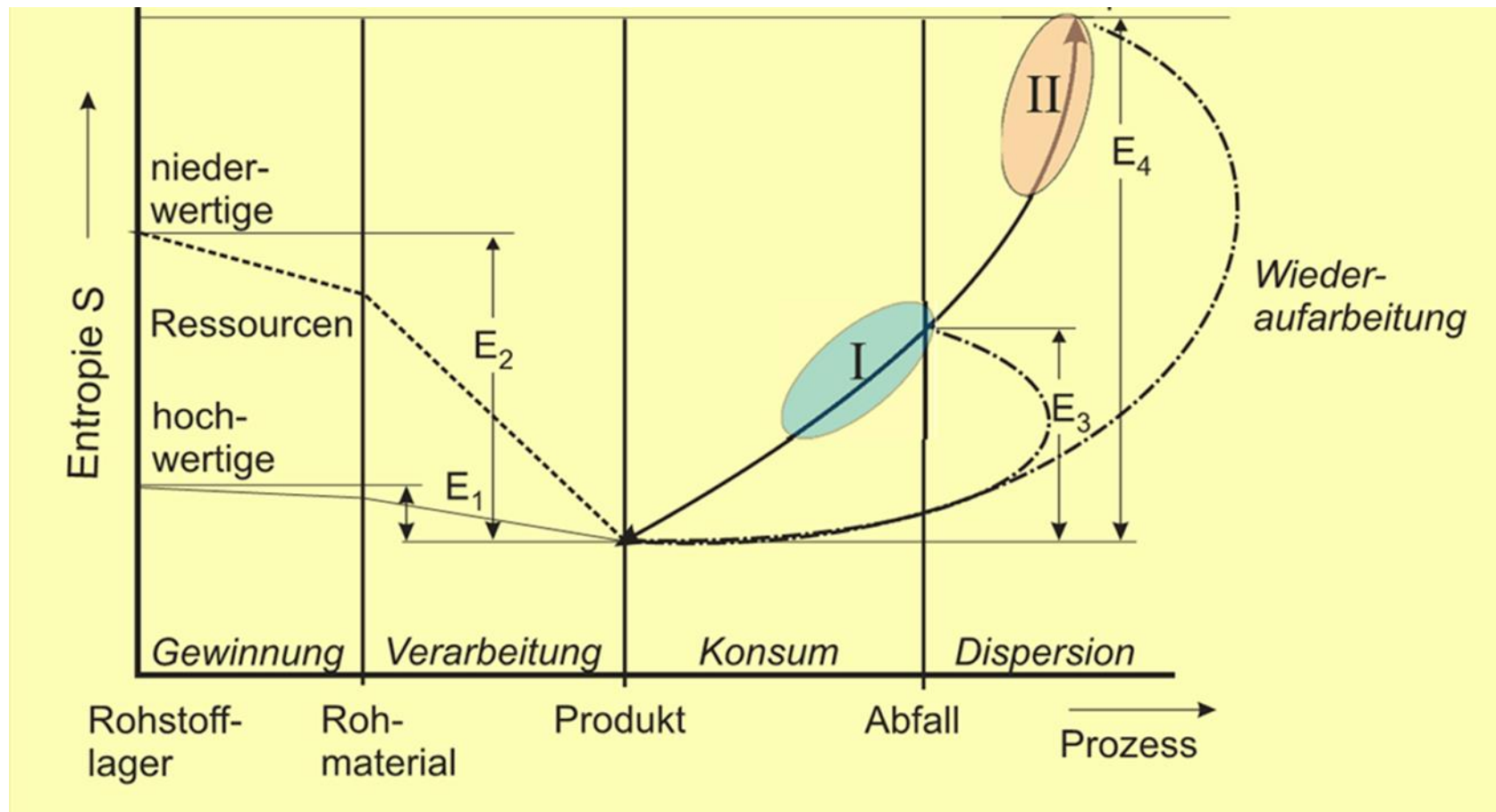
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Is there a difference in value?



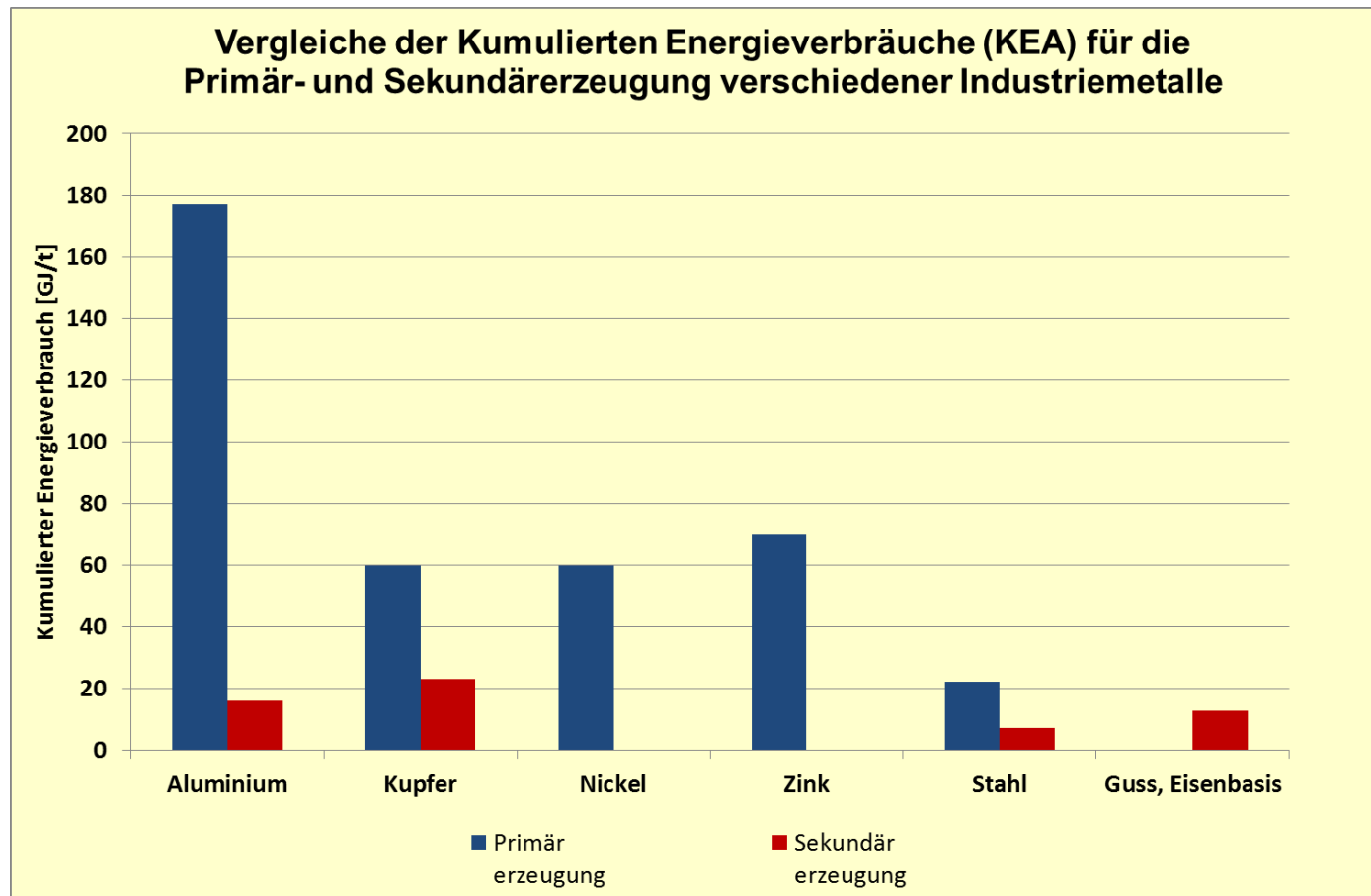
# Entropy development during production use and recycling



Based on: Thermodynamische Aspekte der Abfallverwertung, AbfallwirtschaftsJournal, vol 4, pp.227-238, 1992

Deike, R.: *Die zukünftige Bedeutung des Recyclings metallischer und oxidischer Reststoffe unter dem Aspekt veränderter globaler Rohstoffmärkte*, in Rohstoffeffizienz und Rohstoffinnovationen (Hrsg. U.Teipel u. R.Schmidt), Fraunhofer Verlag, Stuttgart, 2011

## Cumulative energy consumption for different primary and secondary produced metals



Data from [www.probas.umweltbundesamt.de/php/index.php](http://www.probas.umweltbundesamt.de/php/index.php)

Deike, R.: *Die Bedeutung energieintensiver metallurgischer Betriebe unter dem Aspekt des Recyclings von Eisen, Stahl und NE-Metallen*, Berliner Recycling und Rohstoffkonferenz, Berlin, 08.03.16

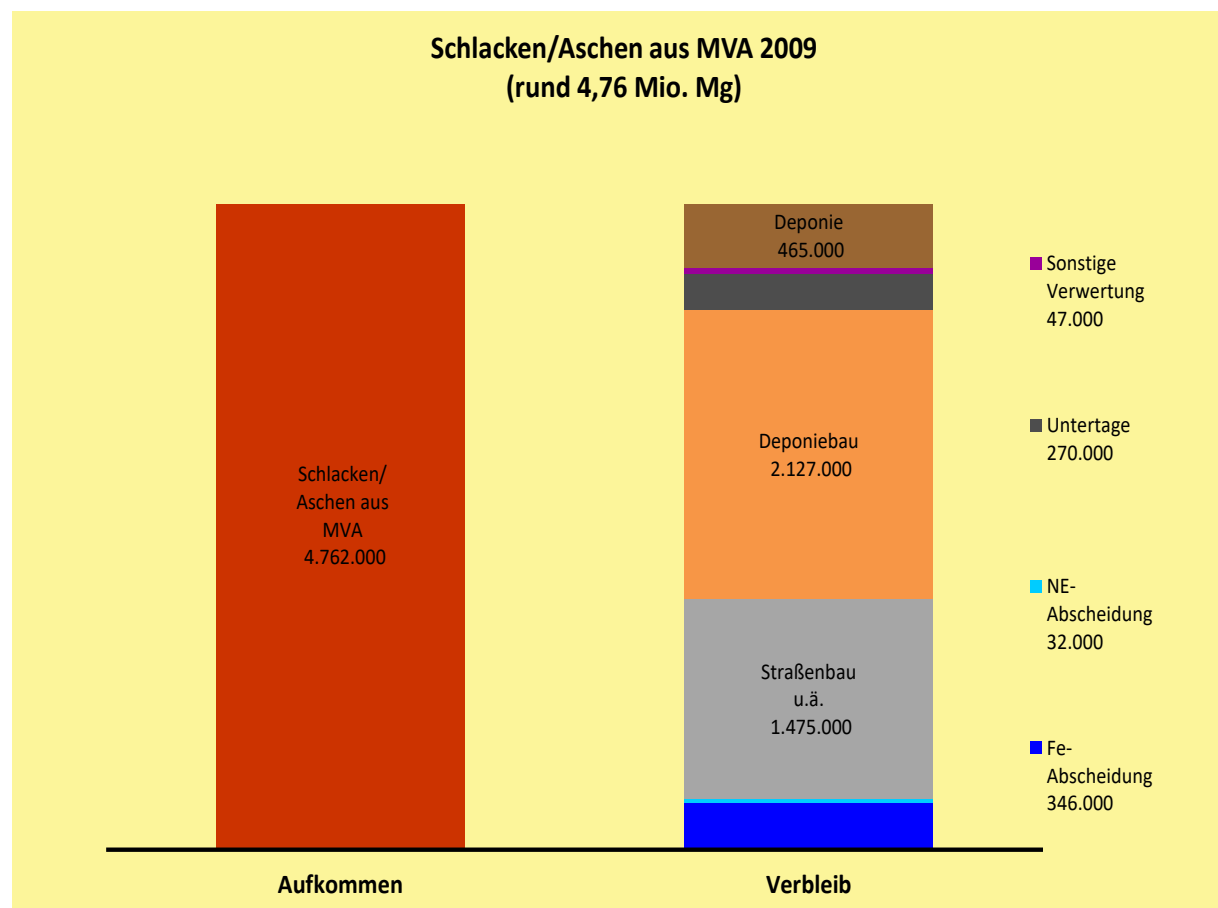
[http://www.vivis.de/phocadownload/2016\\_rur/2016\\_RuR\\_419-436\\_Deike.pdf](http://www.vivis.de/phocadownload/2016_rur/2016_RuR_419-436_Deike.pdf)

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# The use of bottom ash from municipal waste incineration



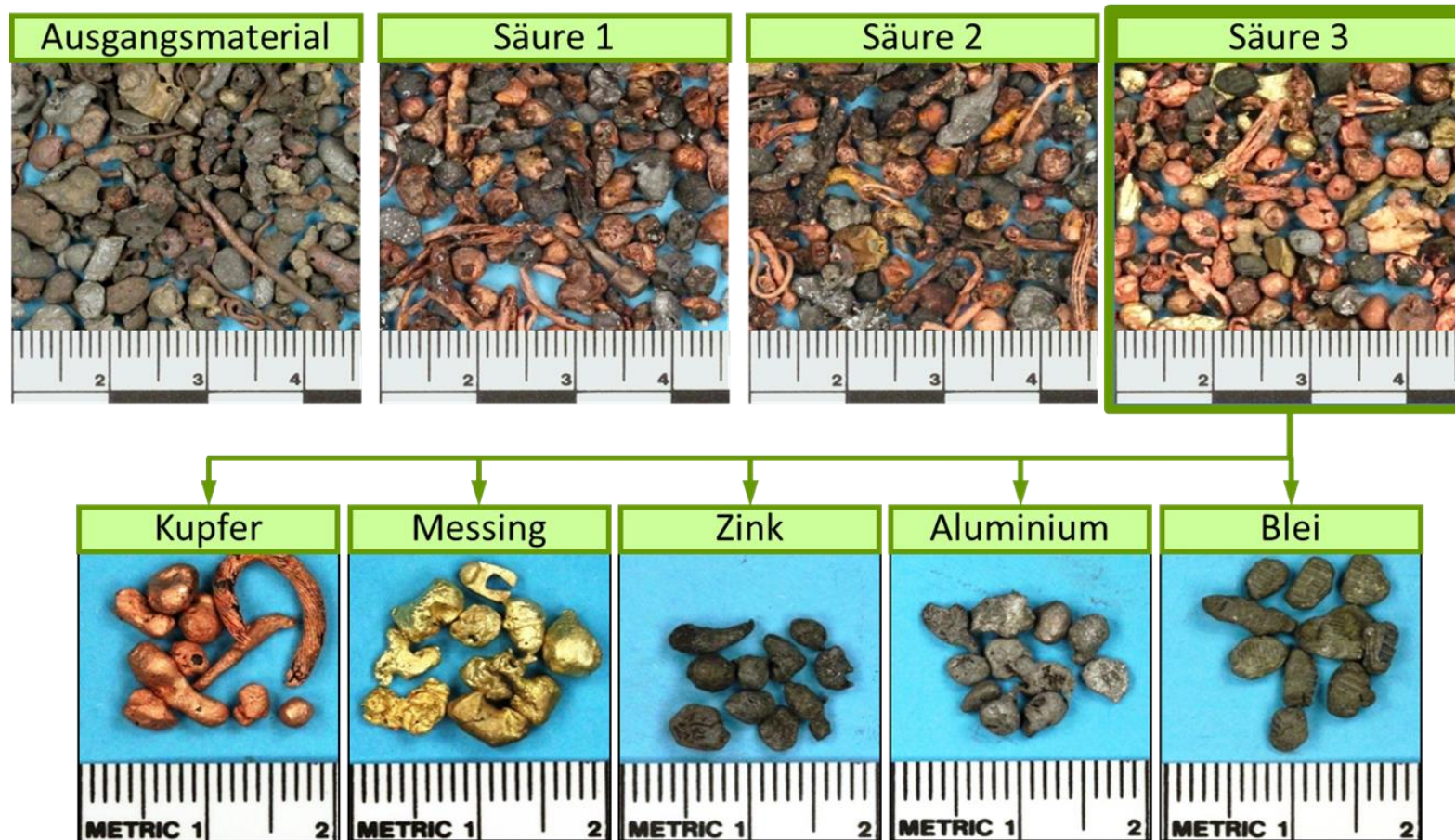
Data from Umweltbundesamt; Verbesserung der umweltrelevanten Qualitäten von Schlacken aus Abfallverbrennungsanlagen

Deike, R.; Ebert, D.; Warnecke, R.; Vogell, M.: *Abschlussbericht zum Projekt „Recyclingpotenziale bei Rückständen aus der Müllverbrennung*, Duisburg 2012,

[www.itad.de/information/studien/20130110DEIKEHMVAREcyclingpotentialAbschlussbericht.pdf](http://www.itad.de/information/studien/20130110DEIKEHMVAREcyclingpotentialAbschlussbericht.pdf)



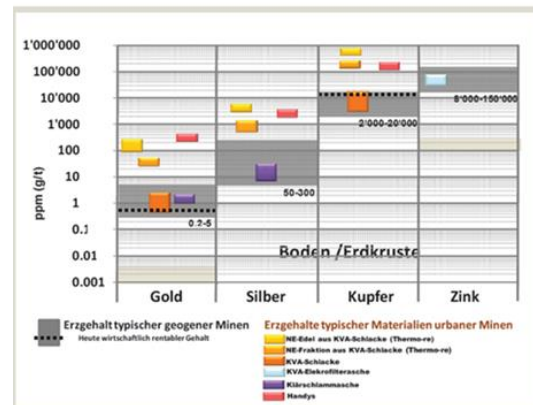
## Metal recovery from bottom ash at the municipal incineration plant KEZO in Hinwil (Switzerland)



Deike, R., Brümmer, A.: *Qualitätssicherung bei der Schlackenaufbereitung – neue Herausforderung*, ZAR –Stiftung  
 Zentrum für Nachhaltige Abfall- und Ressourcennutzung, Hinwil, 21.03.2012, <https://www.zar-ch.ch>

# Bottom ash is an interesting urban mine

## INTERESSANTE URBANE MINEN!



MVA-Verbrennungsrückstände sind

- Mengenmässig
- Ökologisch
- Ökonomisch

betrachtet schon heute interessante urbane Minen.

GROSSE FORTSCHRITTE IN ANALYTIK UND QS SIND BASIS FÜR WEITERENTWICKLUNGEN



Institut für Metallurgie und Umformtechnik  
Technologie der Stelm- und Stahlherzeugung  
Prof. Dr.-Ing. Rüdiger Dicks

Arbeitsmethode: Cu-O1-M  
Komponenten: Cu-Orientation  
Proben Nr.: KVA-Briefbeschwerer 4  
Kurzname:

Proben Id.: Elementkonzentration  
Qualität:

|           | Zn     | Pb    | Min    | Max    |
|-----------|--------|-------|--------|--------|
| 1         | 9.27   | 4.37  | 0.0001 | 0.0001 |
| 2         | 9.28   | 4.41  | 0.0001 | 0.0001 |
| 3         | 9.30   | 4.38  | 0.0001 | 0.0001 |
| < x > (3) | 9.28   | 4.38  | 0.0001 | 0.0001 |
| sd        | 0.0154 | 0.003 | 0.0001 | 0.0001 |
| rel       | 0.2    | 1.4   | 0.0001 | 0.0001 |

|           | Cr     | Fe     | Al     | Si     |
|-----------|--------|--------|--------|--------|
| 1         | 0.0012 | 0.0086 | 0.0032 | 0.0078 |
| 2         | 0.0029 | 0.0091 | 0.0039 | 0.0081 |
| 3         | 0.0027 | 0.0090 | 0.0030 | 0.0082 |
| < x > (3) | 0.0026 | 0.0089 | 0.0030 | 0.0080 |
| sd        | 0.0002 | 0.0003 | 0.0001 | 0.0002 |
| rel       | 7.8    | 3.0    | 4.7    | 2.5    |

|           | Be     | Zr     | As     |
|-----------|--------|--------|--------|
| 1         | 0.0001 | 0.0001 | 0.0001 |
| 2         | 0.0001 | 0.0001 | 0.0001 |
| 3         | 0.0001 | 0.0001 | 0.0001 |
| < x > (3) | 0.0001 | 0.0001 | 0.0001 |
| sd        | 0.0001 | 0.0001 | 0.0001 |
| rel       | 0.0001 | 0.0001 | 0.0001 |

Morff, L.; Böni, D.; DiLorenzo, F.: 12. VDI Fachkonferenz Feuerung und Kessel, Köln, 12.06.13

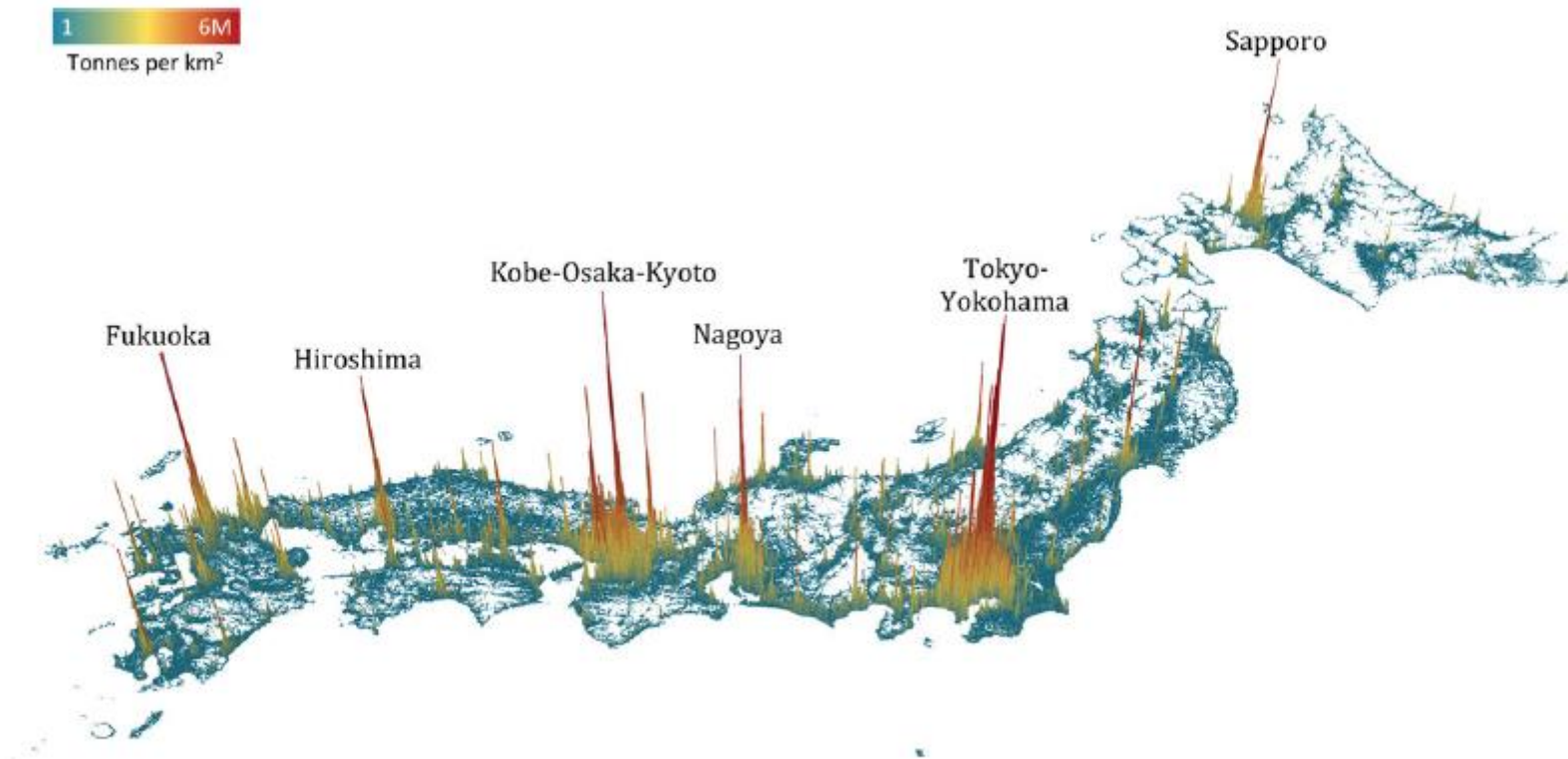


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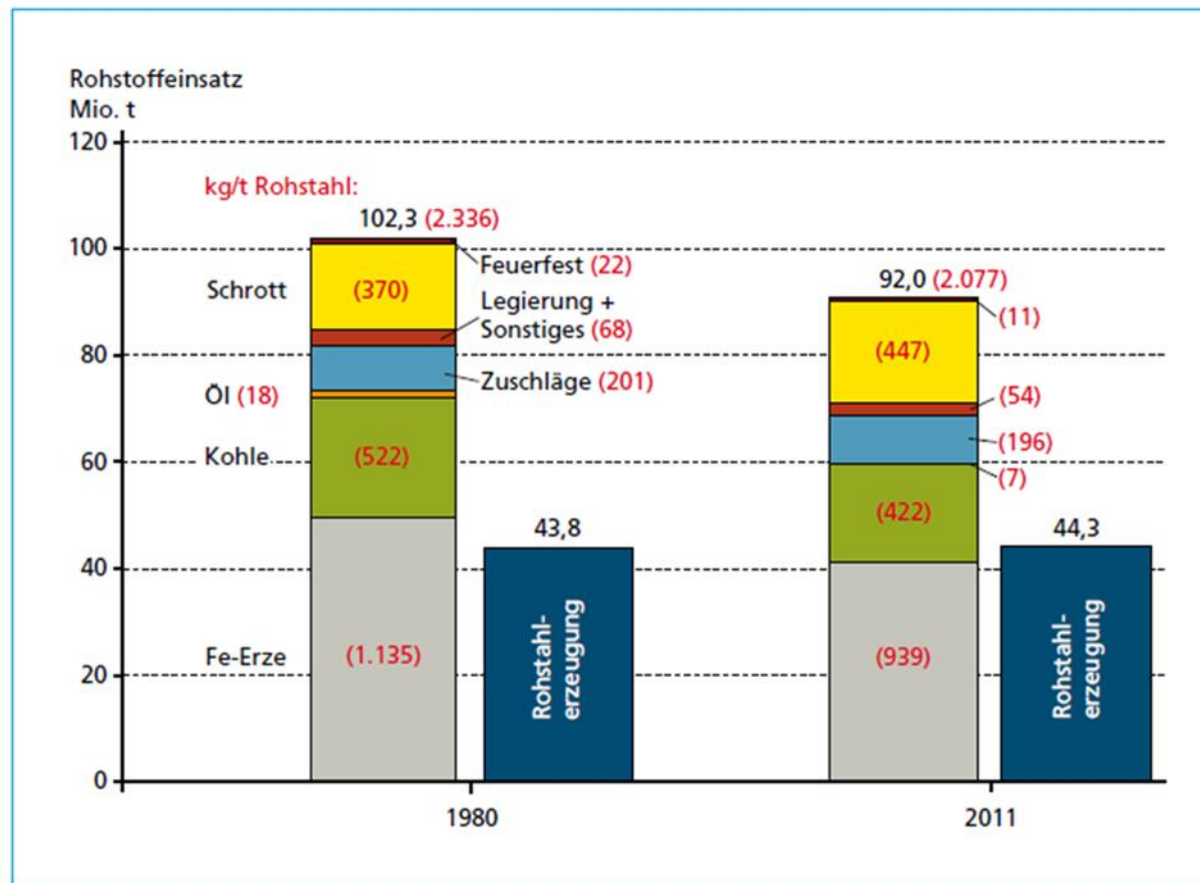
In future the big cities in which raw materials are concentrated become more important as raw material source



**Figure 2** Country-wide spatial distribution of the material stocked in buildings, 2009. Cell size is 1 km<sup>2</sup> using the geographical information systems data set. M = million; km<sup>2</sup> = square kilometer.

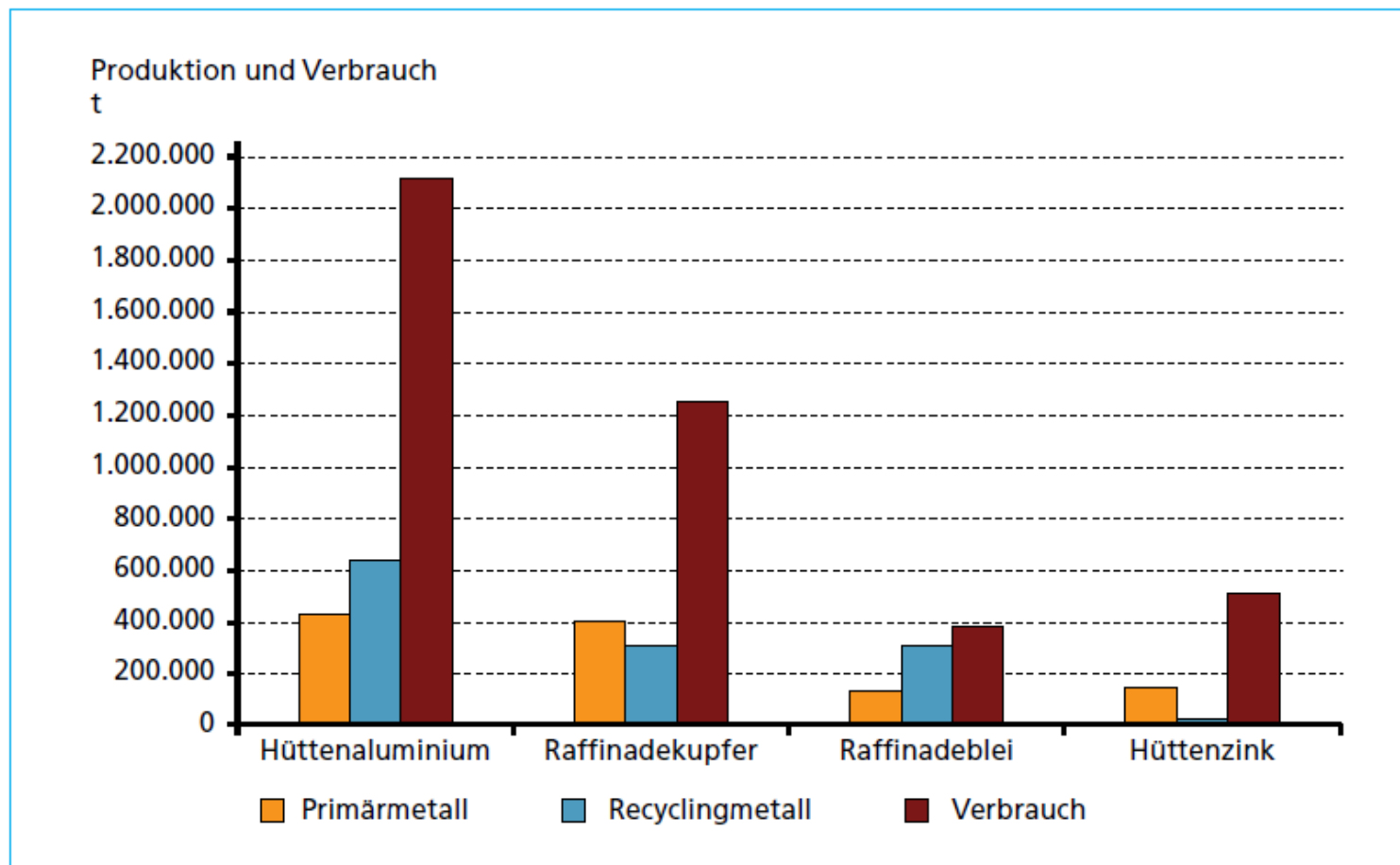
Tanikawa, H.; Fishman, T.; Okuoka, K.; Sugimoto, K.: *The weight of society over time and space*, Journal of Industrial Ecology, Vol. 19, Issue 5, Oct. 2015, p.778-791

The recycling of scrap is the reason why today in Germany less raw material per tonne of crude steel is needed in comparison to the past



Heußen, M.; Markus, H.P.: Ressourcenmanagement eines Elektrostahlwerks, in Aschen-Schlacken-Stäube aus Abfallverbrennung und Metallurgie, (Hrsg. K.J. Thomé-Kozmiensky), TK-Verlag Neuruppin, 2013

**In Germany in some cases the produced tonnages of secondary metal is higher as primary metal, but primary metal is still needed**



Biedermann, H.; Meynerts, U.; Deike, R.: Wie funktioniert der Metallhandel?, in Recycling und Rohstoffe (Ed. Thomé-Kozmiensky u. D.Goldmann), TK-Verlag (ISBN 978-3-944310-09-1), Neuruppin 2014  
[http://www.vivis.de/phocadownload/2014\\_rur/2014\\_RuR\\_289\\_308\\_Biedermann.pdf](http://www.vivis.de/phocadownload/2014_rur/2014_RuR_289_308_Biedermann.pdf)

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## What are the perspectives for Brazilian-German research on circular economy

With metals it is possible to produce from scrap new products with better qualities. During the time of usage, for example of a car, new materials with better mechanical properties are developed in universities and industry. After the usage, when the car has been dismantled and shredded new products with better properties can be produced with a high amount of old scrap. **That is the highest degree of circular economy we do have, a better new quality from waste material and it can be done indefinitely.** Brazil and Germany do have long traditions and a high experience in producing metals and that is the reason why we are able to develop common strategies to solve future problems in circular economy.

## What are the perspectives for Brazilian-German research on circular economy

In future increasing resource efficiency needs the development of processes to recover valuable materials from dissipative distributions. These processes will be complex and they must have ecological and economical advantages. These processes will be based in general on processes (milling, sieving, separation, flotation) we do know from ore preparation and beneficiation. In Brazil exists a higher knowledge and experience in comparison to Germany how to run these processes successfully with high mass flows. In our **joint research project DIBRASS**, together with Brazilian universities and companies, financed by the German ministry BMBF we will develop processes how metals of strategic economic importance can be recovered from slags.

# Thank you for your attention!